

CLAIMS

1. An electron beam system for directing multiple electron beams toward a target, comprising:
 - a system vacuum chamber containing the target;
 - one or more intermediate vacuum chambers, each in selective communication with the system vacuum chamber through a group of vacuum isolation valves;
 - multiple electron gun chambers positioned within each of the one or more intermediate vacuum chambers, each electron gun chamber including an electron source and a gun chamber vacuum isolation valve for vacuum isolating the gun chamber so that the intermediate chamber can be opened to replace an electron gun chamber without exposing the interior of the remaining electron gun chambers to air and the group of isolation valves allowing the intermediate chamber to be vacuum isolated from the system chamber to allow opening the system chamber without exposing the interior of other intermediate chambers to air.
2. The electron beam system of claim 1 in which the vacuum isolation valves in each of the intermediate vacuum chambers correspond to electron optical columns and are connected together to open and close as a group to alternatively seal the intermediate chamber or allow electron beams to pass to the system vacuum chamber.
3. The electron beam system of claim 1 in which each of the multiple electron gun chambers includes a vacuum pump to evacuate the gun chamber.
4. The electron beam system of claim 1 in which each of the multiple electron guns corresponds to an electron column and in which each of the electron optical columns includes at least one electron optical element that is within the system vacuum chamber.

5. The electron beam system of claim 1 in which each of the multiple electron guns corresponds to an electron column and in which each of the electron optical columns includes at least one electron optical elements that is within the intermediate vacuum chamber but outside the corresponding gun chamber.

6. An multiple electron beam system for directing multiple electron beams toward a target, comprising:

a system vacuum chamber containing a target;

one or more intermediate vacuum chambers, each in selective communication with the system vacuum chamber through one or more vacuum isolation valves; and

one or more electron guns positioned within each of the one or more intermediate vacuum chambers.

7. The electron beam system of claim 6 in which each of the multiple electron guns corresponds to an electron optical column and in which each of the electron optical columns includes at least one electron optical element that is within the intermediate vacuum chamber.

8. The electron beam system of claim 7 in which each of the electron optical columns further includes at least one electron optical element that is within the system vacuum chamber.

9. The electron beam system of claim 6 in which multiple electron guns are positioned within one or more sealable gun chambers positioned within the intermediate chamber.

10. The electron beam system of claim 9 in which each of the multiple electron gun is contained within its own sealable gun chamber.

11. The electron beam system of claim 9 in which each of the sealable gun chambers includes multiple electron guns.

12. The electron beam system of claim 9 in which each of the multiple electron guns corresponds to an electron column and in which the electron optical columns each includes at least one electron optical elements that is within the intermediate vacuum chamber but outside the sealable gun chamber.

13. The electron beam system of claim 9 in which each of the one or more sealable gun chambers has an associated vacuum pump for evacuating the chamber and the intermediate chamber has an associated vacuum pump.

14. The electron beam system of claim 6 in which multiple electron guns are positioned directly within the intermediate chamber without being placed in a sealable chamber within the intermediate chamber.

15. The electron beam system of claim 6 in which:

each of the one or more multiple electron guns corresponds to an electron optical column; and

each electron optical column includes at least one additional optical element positioned in the system vacuum chamber.

16. The electron beam system of claim 6 in which:

each of the multiple electron guns corresponds to an electron optical column; and

each electron optical column includes an additional optical elements of a first type, the optical elements of the first type for at least some of the columns being supported and electrically connected by a single sheet of metal.

17. The electron beam system of claim 16 in which the single sheet of metal supports conductive and insulating inserts that form deflection elements.

18. The electron beam system of claim 6 in which each of the one or more electron guns includes an emitter, a suppressor, an extractor element, and a gun lens first element, the gun lens first element being separate from the emitter, suppressor, and extractor element, and being maintained at approximately the same potential as the extractor element.

19. The electron beam system of claim 6 further comprising:
one or more sealable gun chambers within the intermediate vacuum chamber; and
an electron column associated with each electron gun, each electron column including at least one optical element within the intermediate chamber but outside of the sealable gun chamber and at least one optical element in the system chamber.

20. A sealable electron gun chamber comprising:
an electron gun including:
 an emitter for emitting electrons;
 a suppressor adjacent to the emitter for suppressing the unwanted emission of electrons; and
 an extractor for extracting electrons from the emitter;
a vacuum housing containing the electron gun; and
a vacuum isolation valve in the path of electrons when emitted by electron gun, the vacuum isolation valve sealing the vacuum housing when closed and allowing the emitted electrons to pass out of the vacuum housing when opened, the sealable electron gun chamber allowing the electron gun to be conditioned and sealed before being placed into an electron beam system.

21. The sealable electron gun chamber of 20 further comprising a vacuum pump for evacuating the vacuum housing.

22. The sealable electron gun chamber of 20 in which the electron gun further comprises a gun lens for focusing the electrons emitted by the emitter.

23. The sealable electron gun chamber of 20 further comprising one or more additional electron guns, each additional electron gun including an emitter, a suppressor, and an extractor.

24. The sealable electron gun chamber of 20 in which the emitter is conditioned and the vacuum isolation valve is closed to maintain the emitter in the conditioned state.

25. An electron beam system including multiple electron sources, comprising:

a system vacuum chamber including a target; and

one or more gun vacuum chambers, each gun vacuum chamber including one or more electron guns and capable of being separately sealed, thereby allowing one of the electron chamber guns to be replaced with without exposing the other electron guns to air and allowing a gun chamber to be preconditioned, sealed, and inserted into the electron beam system, thereby eliminating the requirement to condition the electron gun within the electron beam system.

26. The electron beam system of claim 25 in which each of the one or more gun vacuum chambers includes a vacuum pump.

27. The electron beam system of claim 25 in which each of the electrons guns is associated with an electron optical column including optical elements to focus and direct the electron beam toward the target, at least one optical element of each electron column positioned in the system vacuum chamber.

28. The electron beam system of claim 27 further comprising an intermediate vacuum chamber selectively opening to one or more of the multiple gun vacuum chambers and to the system vacuum chamber, at least one optical element of each electron column positioned in the intermediate vacuum chamber, the electrons from each electron gun traveling from the gun vacuum chamber through the intermediate vacuum chamber to a target in the system vacuum chamber.

29. A method of replacing one or more electron sources in an electron beam system including a sealable electron gun chamber having a vacuum isolation valve, the method comprising:

evacuating a sealable gun chamber containing one or more electron sources;

conditioning the one or more electron sources;

sealing the sealable gun chamber;

inserting the sealed gun chamber into an electron beam system;

unsealing the sealable gun chamber, thereby providing a path for one or more electron beam from the one or more electron sources to a target.

30. The method of claim 29 in which evacuating a sealable gun chamber includes placing the gun chamber in a vacuum chamber that is then evacuated and in which sealing the gun chamber is performed after conditioning the electron source.

31. The method of claim 29 in which sealing the gun chamber is performed before evacuating a sealable gun chamber.

32. The method of claim 29 in which conditioning the emitter includes baking the emitter.

33. The method of claim 29 in which evacuating a sealable gun chamber containing one or more electron sources includes evacuating a sealable gun chamber containing multiple electron sources.

34. The method of claim 29 in which inserting the sealed gun chamber into an electron beam system includes inserting the sealed gun chamber into an intermediate chamber that is separated by one or more vacuum isolation valves from a system chamber containing a target.

35. The method of claim 29 in which the electron beam system includes deflectors for deflecting an electron beam and an objective lens for focusing the electron beam and further comprising finely focusing an electron beam by applying a relatively small voltage to deflectors that are positioned above the objective lens.

36. A method of replacing an electron source in a multiple electron beam system including multiple intermediate chambers, each containing multiple electron gun chambers, the multiple intermediate chambers including one or more vacuum valves for isolating the intermediate chamber from a system chamber including a target, the multiple electron gun chambers each positioned within one of the intermediate chambers and each having a vacuum isolation valve for sealing the electron gun chamber within the intermediate chamber, the method comprising:

37. An electron beam system including multiple electron columns, comprising:

multiple electron guns; and

multiple electron columns, each column including lower deflection elements, the lower deflection elements for the multiple electron columns being formed from the same sheet of metal

with insulator and deflection plate inserts and capable of being biased to provide fine focusing of the electron columns.

38. In an electron beam system including deflectors for deflecting an electron beam and an objective lens for focusing the electron beam, a method of finely focusing electron columns in a charged particle beam system comprising applying a relatively small voltage to deflectors that are positioned above the objective lens.

39. An electron gun comprising

an emitter for emitting electrons;

an extractor for applying an extraction voltage to extract electrons from the emitter, the extractor being at an extraction electrical potential in relation to the emitter;

a suppressor for suppressing the emission of undesirable electrons; and

a gun lens first element that is separate from the emitter, suppressor, and extractor element, and is maintained at approximately the same potential as the extractor.